

# Living Health Economic Evaluation (with R)

Dr. Robert Smith & Dr. Paul Schneider

NICE Technical Forum  
17th May 2023



University of  
Sheffield

# Who are we anyway?



Dr. Paul Schneider



Dr. Robert Smith



Dr. Sarah Bates





ShangShang Gu





Wael Mohammed

# MS Excel vs R (python / others)

|   |                                  |  |  | Comments                                 | Link to Slide                        |
|---|----------------------------------|---|---|--|--------------------------------------|
| 1 | Familiarity<br>Barriers to entry | ● ● ● ●   | ●   | Coding in R is hard                      | <a href="#">Teaching</a>             |
| 2 | Capabilities                     | ● ●   | ● ● ● ●   | ... but much more powerful               | <a href="#">Comparison</a>           |
| 3 | Computational Speed              | ●   | ● ● ● ●   | ... and faster                           | <a href="#">Benchmark</a>            |
| 4 | Development &<br>Iteration speed | ● ●   | ● ● ● ●   | ... and easier to develop at scale       | <a href="#">Living HTA</a>           |
| 5 | Transparency                     | ● ●   | ● ● ● ●   | ... and more robust (int. & ext. review) | <a href="#">Packages; Data/model</a> |
| 6 | Engagement & Visualisation       | ● ● ●   | ● ● ● ●   | ... and looks better                     | <a href="#">Shiny UI</a>             |

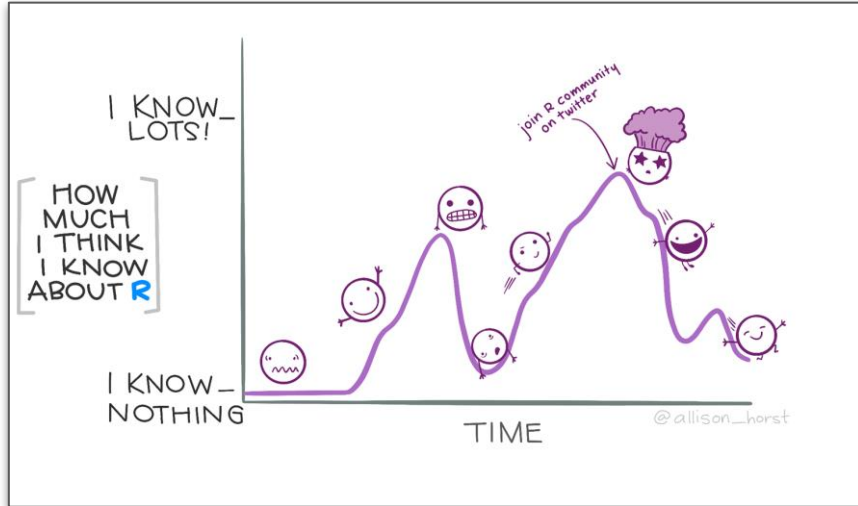
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# (Not so) Short Course



Building Health Economic Models in R

Search

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- References

## 8 Automated Reporting

### 8.1 Background

One of the benefits of building models in R is that we can write code to generate reports based on the inputs and outputs of our model. This was a crucial part of our proposed transition of the health economic evaluation pipeline towards something that looks like this:

New pipeline

This section guides the reader through the process of writing such a report using two R packages, `Rmarkdown` (for a PDF document) and `officeR` (for a Powerpoint presentation). Both packages are able to output in a large number of formats.



We show how to write these reports in such a way to be functional and aesthetically pleasing, and show how to write a single script which runs a health economic model and then renders a PDF or set of Powerpoint slides using the parameters and results of

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<https://r4he.netlify.app/about-the-authors.html>

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# If statistics programs/languages were cars ...





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# Computational speed

27<sub>x</sub> faster

|  | R    | Excel |
|--|------|-------|
| Average Time (seconds)<br>required for 10,000<br>simulations | 31.8 | 872.7 |



Hollman, C., Paulden, M., Pechlivanoglou, P. and McCabe, C., 2017. A comparison of four software programs for implementing decision analytic cost-effectiveness models. *Pharmacoeconomics*, 35(8), pp.817-830.

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Pharmacoeconomics (2023) 41:227–237  
https://doi.org/10.1007/s40273-022-01229-4

## LEADING ARTICLE



## Living Health Technology Assessment: Issues, Challenges and Opportunities

Praveen Thokala<sup>1</sup> · Tushar Srivastava<sup>1,2</sup> · Robert Smith<sup>1,3</sup> · Shijie Ren<sup>1</sup> · Melanie D. Whittington<sup>4</sup> · Jamie Elvidge<sup>5</sup> · Ruth Wong<sup>1</sup> · Lesley Uttley<sup>1</sup>

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### Abstract

Health technology assessments (HTAs) are typically performed as one-off evaluations and can potentially become out-of-date due to the availability of new data, new comparators, or other factors. Recently, living approaches have been applied to systematic reviews and network meta-analyses to enable evidence syntheses to be updated more easily. In this paper, we provide a definition for 'Living HTA' where such a living approach could be applied to the entire HTA process. Living HTA could involve performing regular or scheduled updates using a traditional manual approach, or indeed in a semi-automated manner leveraging recent technological innovations that automate parts of the HTA process. The practical implementation of living HTA using both approaches (i.e., manual approach and using semi-automation) is described along with the likely issues and challenges with planning and implementing a living HTA process. The time, resources and additional considerations outlined may prohibit living HTA from becoming the norm for every evaluation; however, scenarios where living HTA would be particularly beneficial are discussed.

### Key Points for Decision Makers

Health technology assessments (HTAs) are typically performed as one-off evaluations and can quickly become out-of-date.

Living HTA approaches can ensure that the HTAs are up-to-date, and potentially living HTAs could be updated manually or (semi-)automatically using innovative software platforms.

However, living HTA involves substantial time, planning and resource commitments, and as such should only be used in situations where it is important to ensure the HTA is up-to-date.

### 1 Introduction

Health technology assessment (HTA) agencies perform evaluation of clinical and cost-effectiveness evidence of new interventions to decide whether they should be reimbursed.

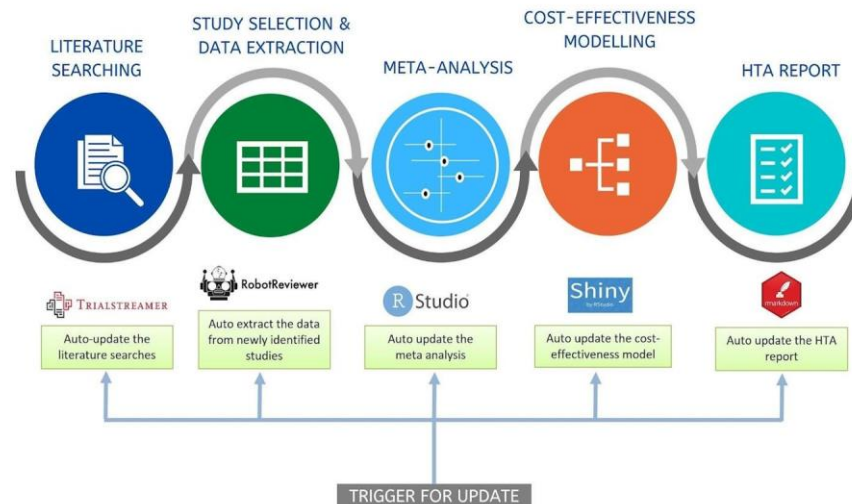
Extended author information available on the last page of the article

These are typically performed as one-off evaluations and can potentially become out-of-date due to various reasons (e.g., availability of new data, new comparators, new methods, etc.). While some HTA agencies perform updates of HTAs periodically if certain criteria are met, these updates are typically a few years apart and the results of updates may already be out-of-date by the time of the publication.

There is growing recognition of the need for the HTA process to respond to an evolving evidence base, particularly in reimbursement decisions with high uncertainty. A recent paper on 'Life-cycle HTA' suggests that HTA must explore the value of health technologies from inception through maturity, and proposes a model for integrating changes arising from new evidence to feed into adoption, no adoption and disinvestment decisions [1]. However, as far as we know, there is no literature on the practicalities of performing a responsive, dynamic HTA (which we call 'Living HTA').

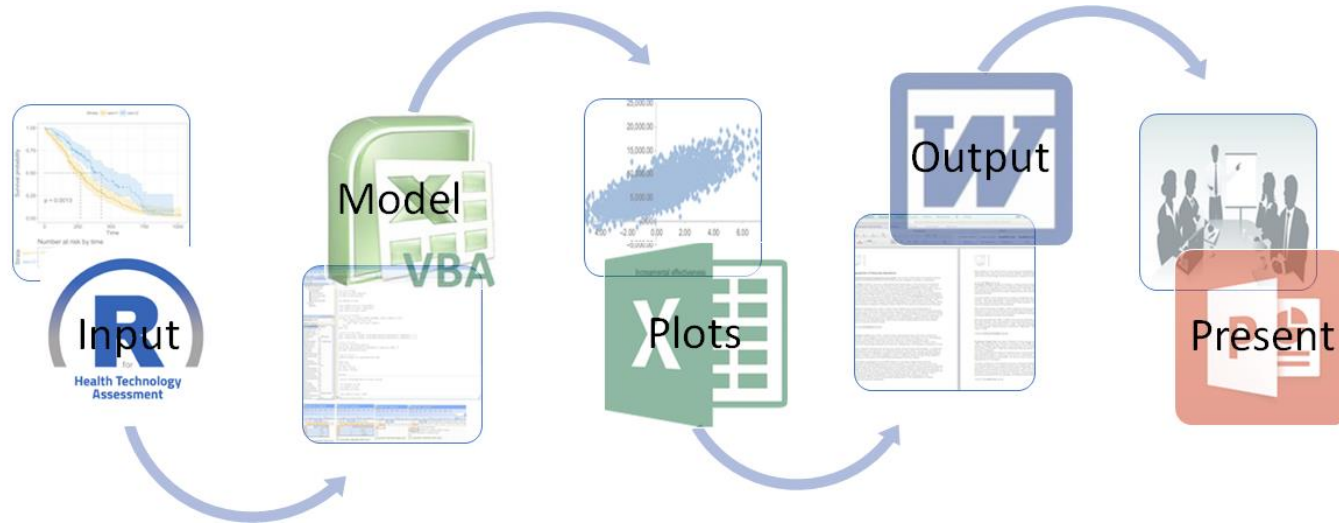
While examples of living systematic reviews and living meta-analyses are already well established, living HTA is not yet fully defined or understood. In this paper, we outline the ways in which the different parts of HTA can 'become' out-of-date, and provide a definition for living HTA and the situations in which it could be useful. While there are similarities between living HTA and the updates that HTA groups make, we outline how the living HTA process could potentially be operationalised from the outset, provide

Figure 3: Potential example living HTA using (semi-)automation

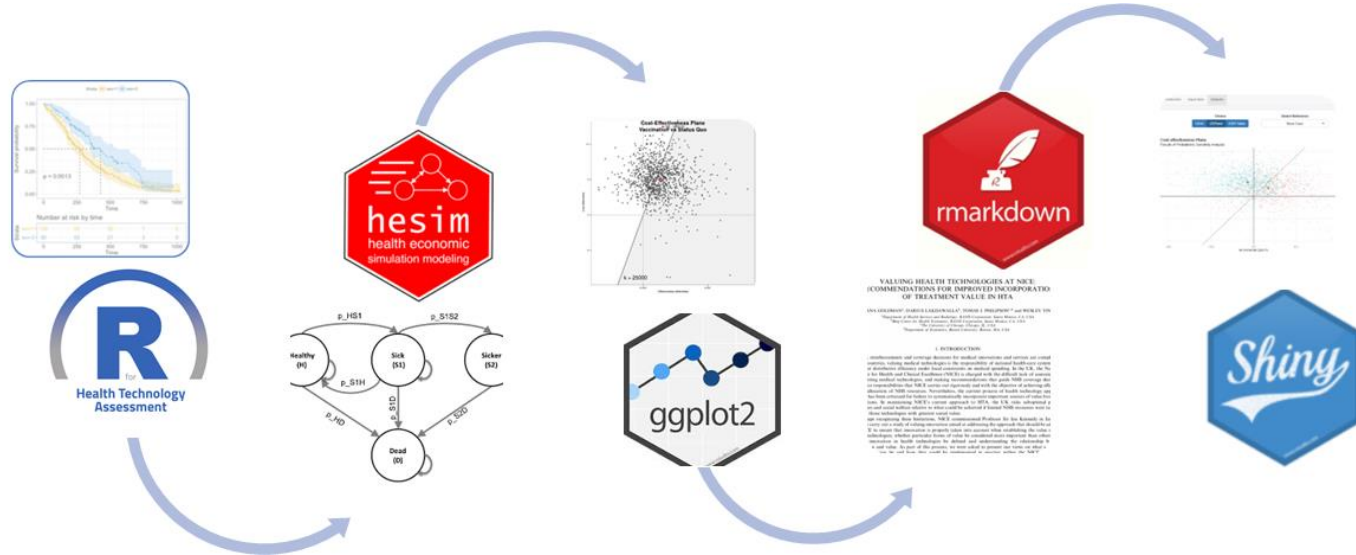


Thokala, P., Srivastava, T., **Smith, R.**, Ren, S., Whittington, M.D., Elvidge, J., Wong, R., Uttley, L. (2023). Living Health Technology Assessment – Issues, Challenges and Opportunities. *Pharmacoeconomics*.

# Current process



# Future process



# Living HTA

Wellcome Open Research

Wellcome Open Research 2022, 7:194 Last updated: 24 OCT 2022

Check for updates

METHOD ARTICLE

**REVISED** Living HTA: Automating Health Economic Evaluation

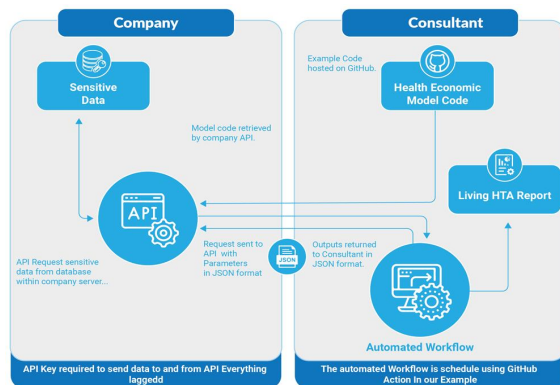
with R [version 2; peer review: 2 approved]

Robert A. Smith<sup>1,3</sup>, Paul P. Schneider<sup>1,3</sup>, Wael Mohammed<sup>1,3</sup>

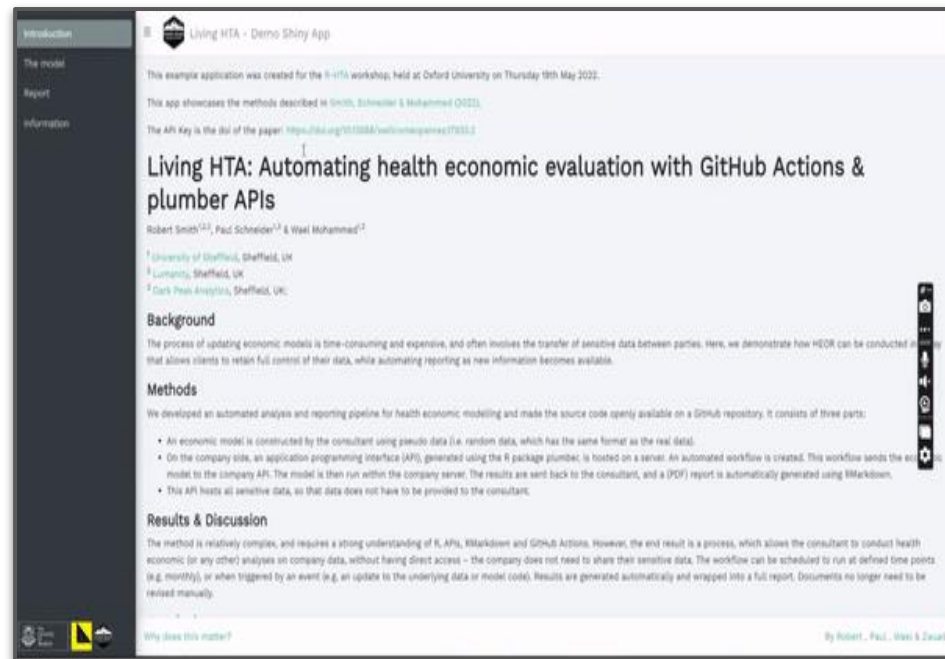
<sup>1</sup>School of Health and Related Research, University of Sheffield, Sheffield, S1 4DA, UK

<sup>2</sup>Lumany, Sheffield, S1 2GQ, UK

<sup>3</sup>Dark Peak Analytics, Sheffield, S11 7BA, UK



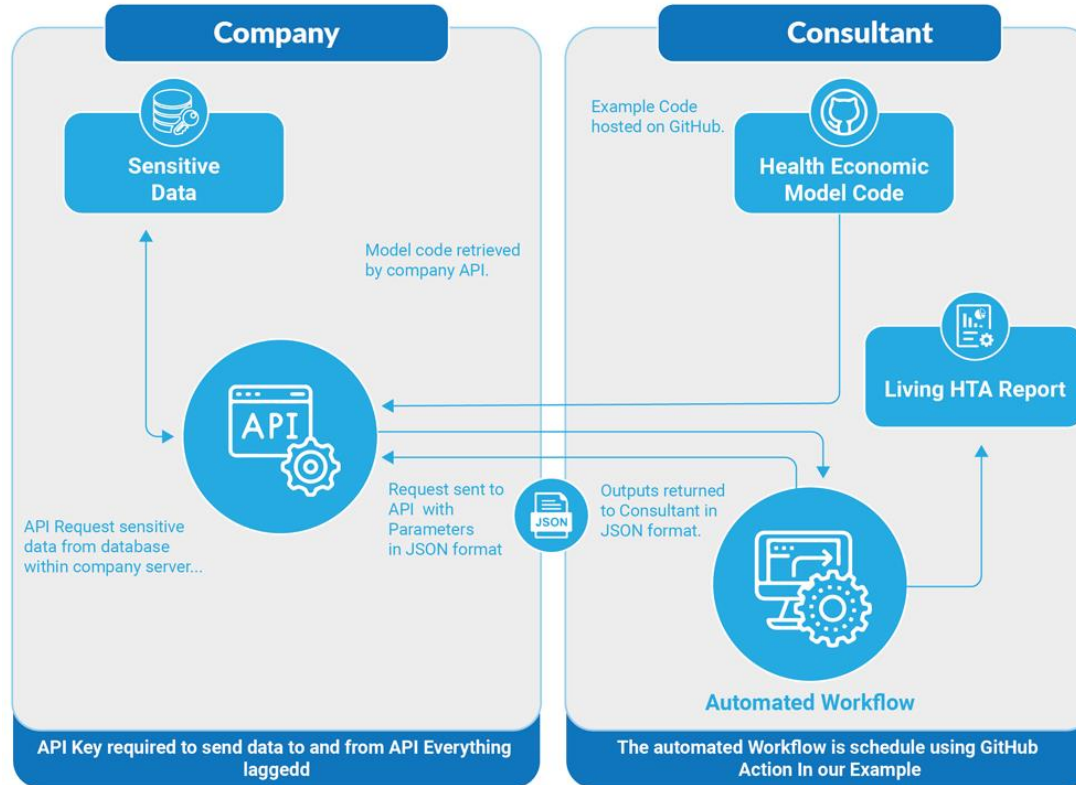
**Smith RA, Schneider PP and Mohammed W.** Living HTA: Automating Health Economic Evaluation with R. *Wellcome Open Res* 2022, **7**:194 (<https://doi.org/10.12688/wellcomeopenres.17933.2>)



[https://darkpeakanalytics.shinyapps.io/living\\_HTA\\_demo/](https://darkpeakanalytics.shinyapps.io/living_HTA_demo/)



# Living HTA



# MS Excel vs R (python / others)



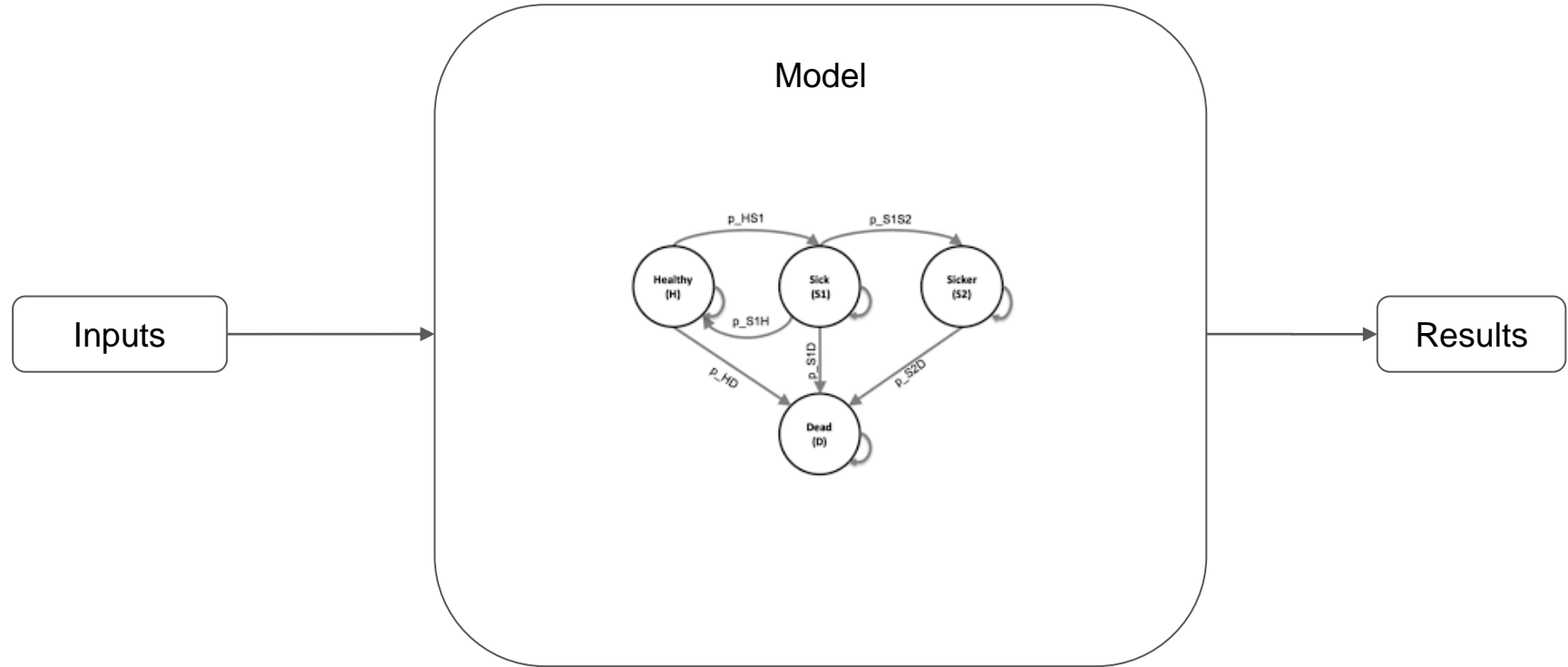
Comments

Link to Slide

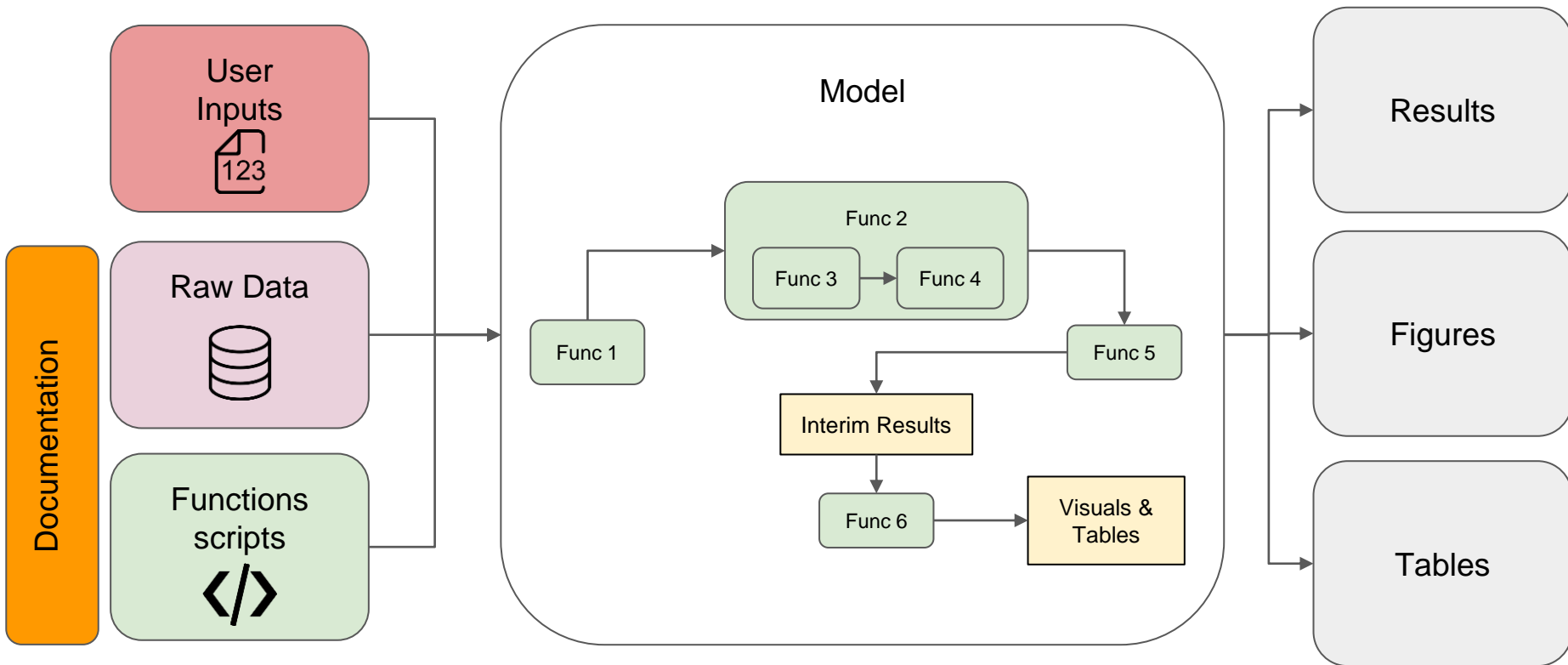
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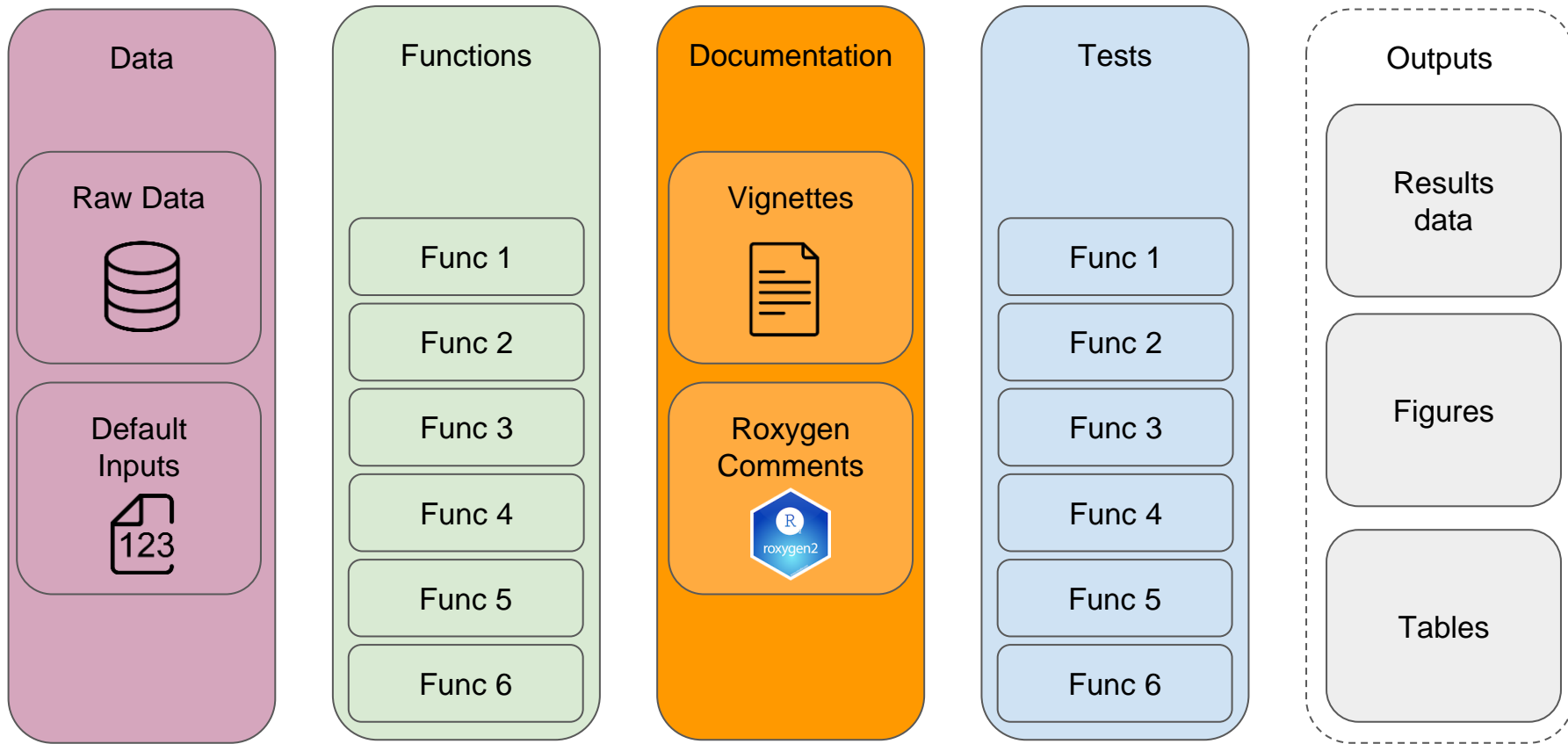
# Building a model in R



# Building a model in R





# Building a model in R



# Benefits of using a Package vs non-packaged code.

1. Every Package will have a similar structure
  - a. Improves familiarity with models.
2. Documentation by default
  - a. Vignettes to show how the package works (walking the user through the code).
  - b. Roxygen comments on every function (exactly what is it doing)
3. Unit testing is built-in
  - a. Testing gives modeller confidence in their methods.
  - b. Testing allows reviewers to 'test the tests' rather than from scratch.
4. Functions are more easily distributed (e.g. `install_github("your-package")`)
  - a. Therefore don't have to continually re-invent wheels
  - b. Standardisation (pros and cons)
  - c. Validation (easier to review, more confidence)

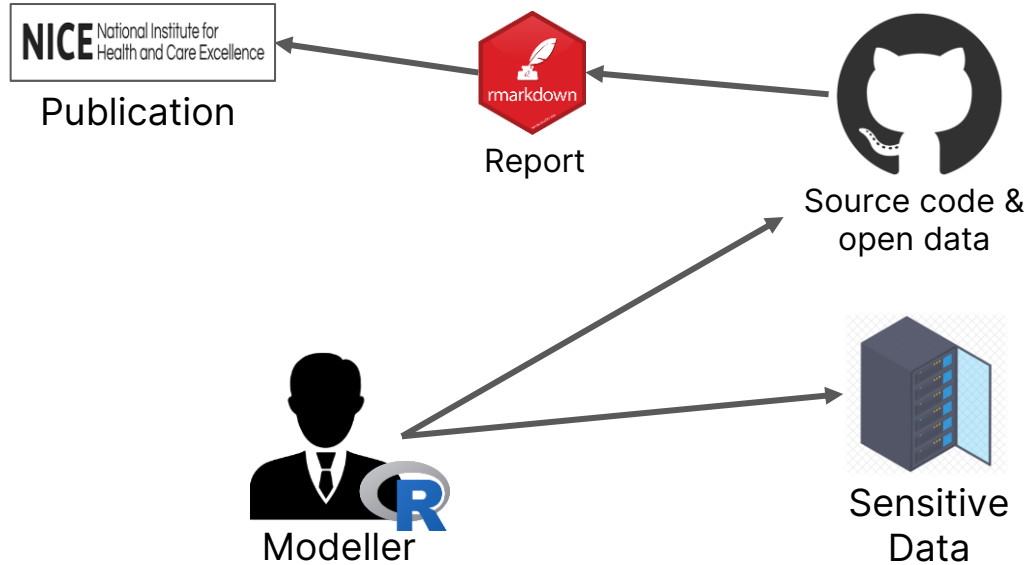
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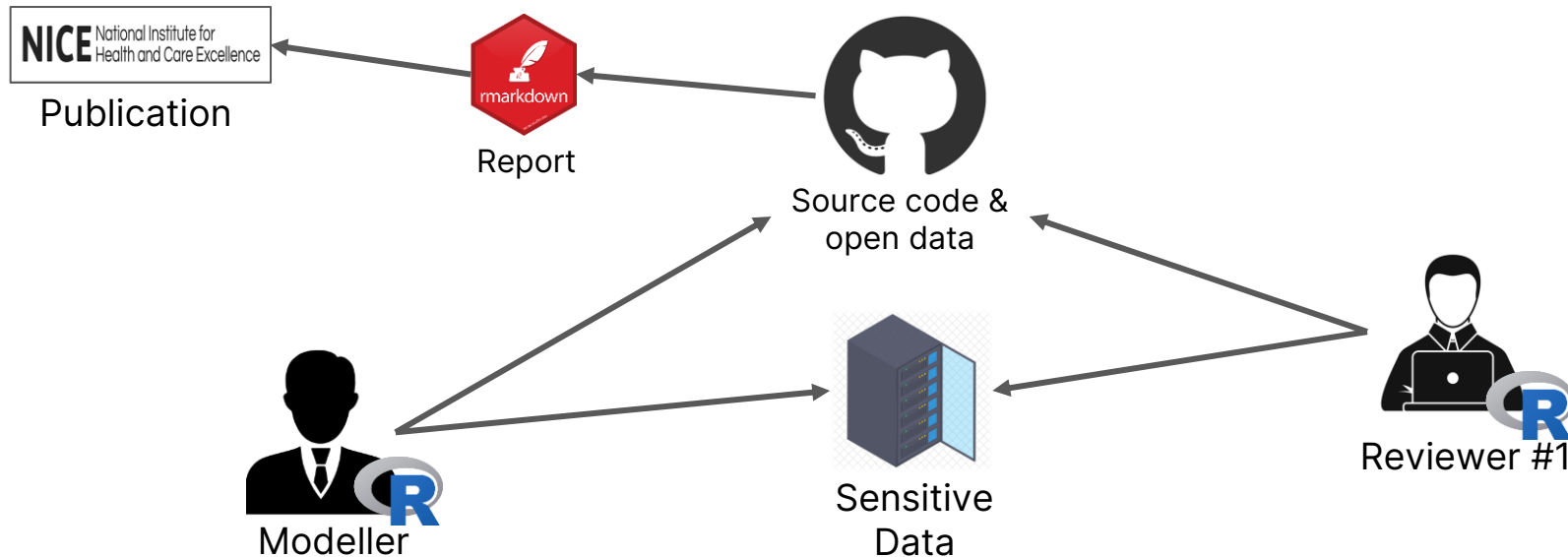
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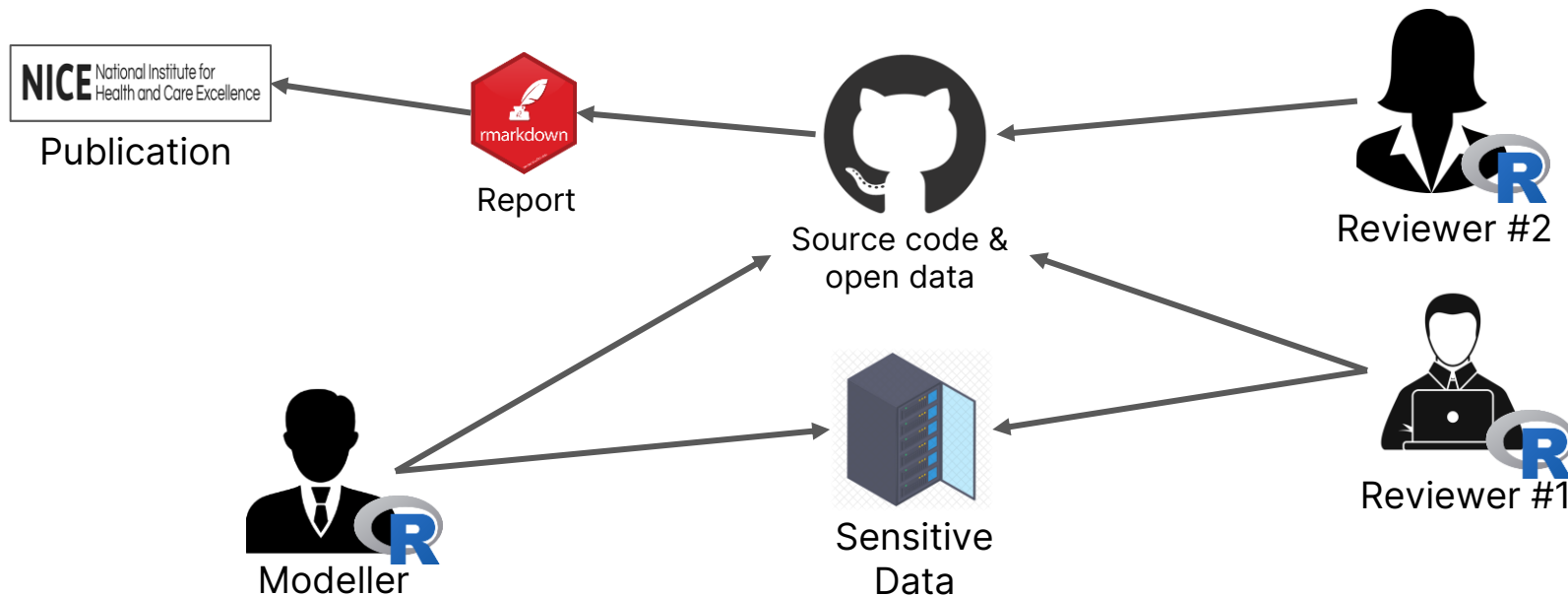
# External review options



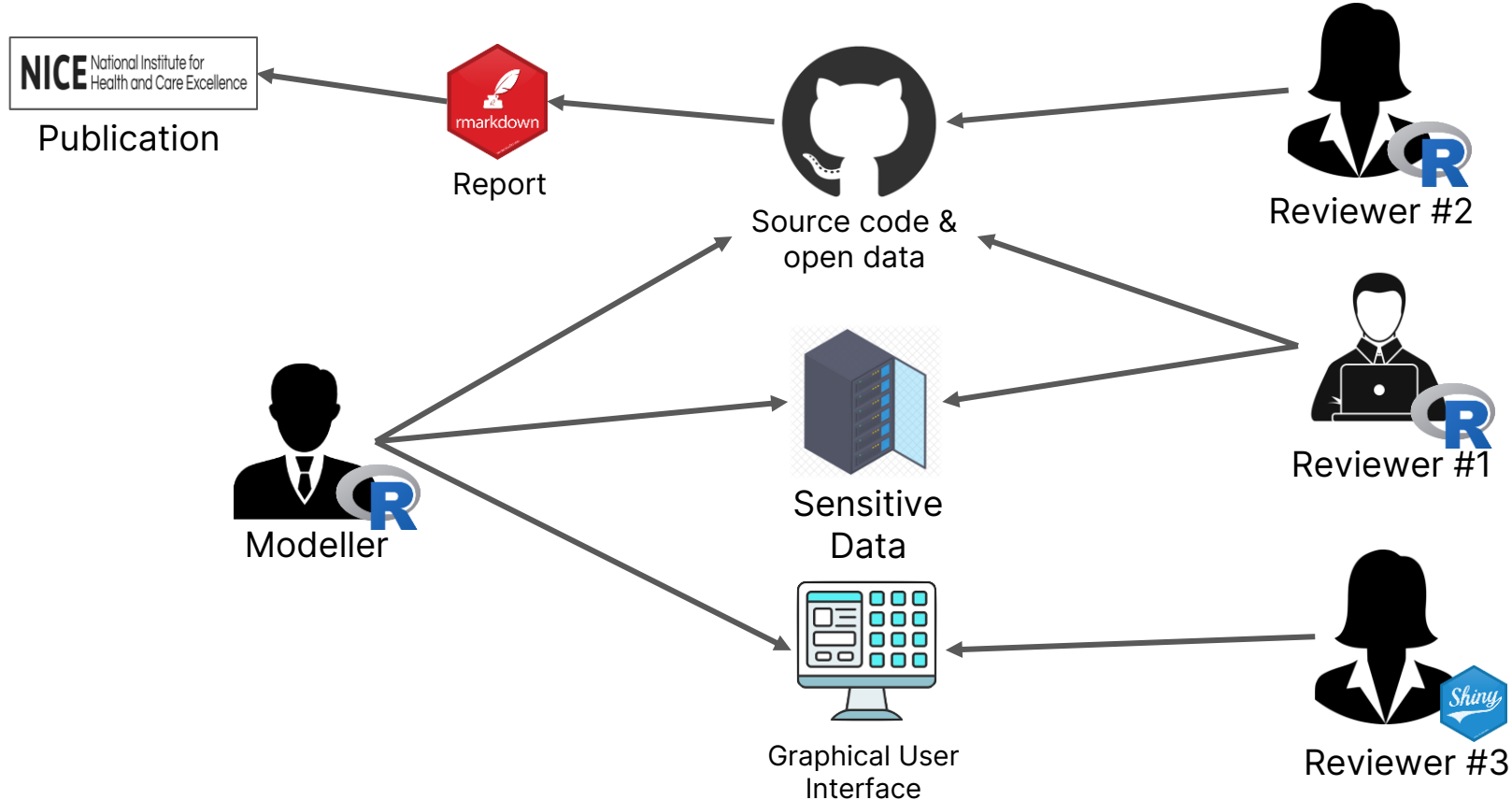
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# External review options



# External review options



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Wellcome Open Research

Wellcome Open Research 2020, 5:69 Last updated: 05 JUL 2022



METHOD ARTICLE

## REVISITED Making health economic models Shiny: A tutorial

[version 2; peer review: 2 approved]

Robert A. Smith<sup>1</sup>\*, Paul Schneider<sup>1</sup>\*

School of Health and Related Research, University of Sheffield, Regents Court, Sheffield, S1 4DA, UK

\* Equal contributors

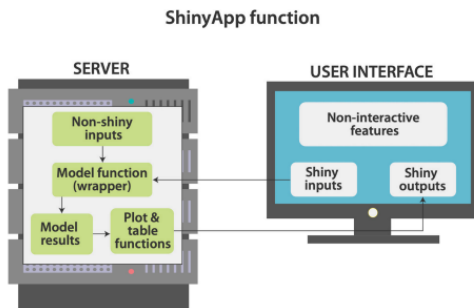
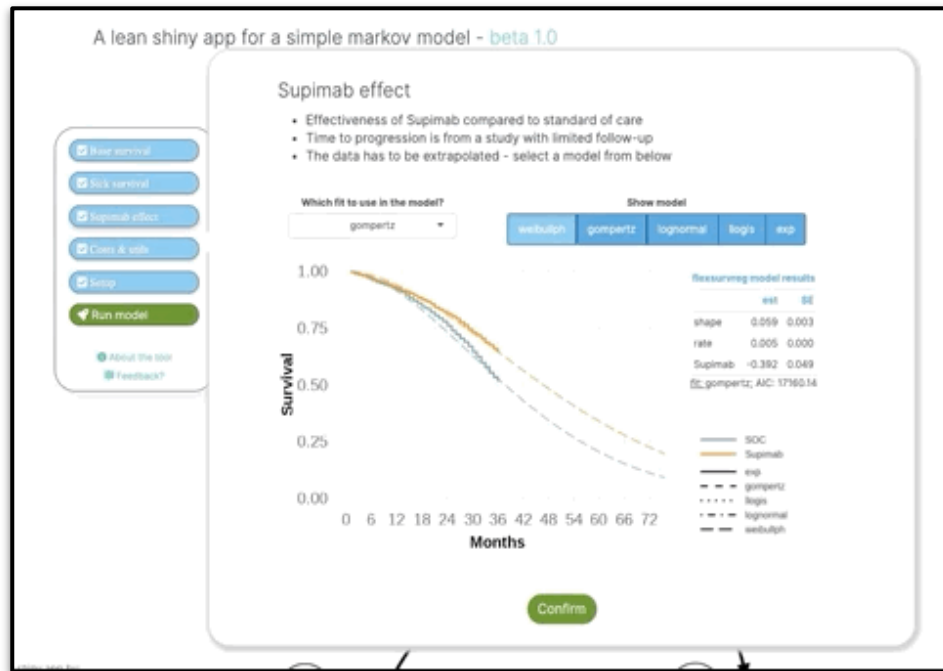


Figure 1. Diagram depicting how the Sick-Sicker app is structured.



**Smith RA** and **Schneider PP**. Making health economic models Shiny: A tutorial. *Wellcome Open Res* 2020, **5**:69 (<https://doi.org/10.12688/wellcomeopenres.15807.2>)

<https://darkpeakanalytics.shinyapps.io/sadm-mk2/>

# Long term vision





# Challenges and Opportunities

## Challenges:

1. Skills gap
2. Wariness of disruption
3. Transparency (concerns around)
4. First movers ?

## Opportunities

1. Increased modelling efficiency (and ease of review)
2. Increased transparency (benefits of)
3. Potential for open source peer review
4. Establishing best practices & standardisation of methods



– Thanks from Sheffield –

[darkpeakanalytics.com/](https://darkpeakanalytics.com/)  
[contact@darkpeakanalytics.com/](mailto:contact@darkpeakanalytics.com)  
[github.com/dark-peak-analytics](https://github.com/dark-peak-analytics)



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# Further resources

## Peer Reviewed Publications

**Smith, R.A., and Schneider, P.P.** (2020). Making health economic models Shiny: A tutorial. *Wellcome Open Res*, 5, 69.  
<https://doi.org/10.12688/wellcomeopenres.15807.2>

**Smith, R.A., Schneider, P.P., and Mohammed, W.** (2022). Living HTA: Automating Health Economic Evaluation with R. *Wellcome Open Res*, 7, 194. <https://doi.org/10.12688/wellcomeopenres.17933.2>

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**Smith, R.A.**, Mohammed, W. and **Schneider, P.P.** (2023). R Packages for health economic evaluation: A tutorial. *Wellcome Open Res (In Press)*.

## Open Source Code

Source code for Shiny:

[https://github.com/RobertASmith/healthecon\\_shiny](https://github.com/RobertASmith/healthecon_shiny)

Source code code for Living HTA:

<https://github.com/RobertASmith/plumberHE>

Source code for Packages:

<https://github.com/dark-peak-analytics/sicksickerPack>